An Evaluation of the Partisan Bias in Michigan's 2011 Districting Plan and its Effects on Representation in Congress and State Government

Christopher Warshaw

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of the two-party vote) or a small minority (e.g., 20%). The former is achieved by "cracking" local opposing-party majorities across multiple districts and the latter by "packing" them into a few overwhelming strongholds. Both types of districts "waste" more votes of the disadvantaged party than of the advantaged one. This suggests that gerrymandering can be measured based on the number of wasted votes for each party.

In a "cracked" district, the disadvantaged party narrowly loses, wasting a large number of votes without winning a seat. In a "packed" district, the disadvantaged party wins overwhelmingly, wasting a large number of votes above the 50%+1 needed to win. The resulting asymmetry in the efficiency of the vote–seat relationships of the two parties lies at the core of normative and constitutional critiques of partisan gerrymandering.

There are a number of approaches that have been proposed to measure asymmetries in the efficiency of the vote–seat relationships of the two parties. In recent years, at least 10 different approaches have been proposed (McGhee 2017). While no measure is perfect, much of the recent literature has used a simple yet powerful way to operationalize this concept of partisan gerrymandering called the *Efficiency Gap* (EG) (McGhee 2014; Stephanopoulos and McGhee 2015; Caughey, Tausanovitch, and Warshaw 2017; Brennan Center 2017; Chen 2017; Stephanopoulos 2018). I use this metric as the primary tool to measure partisan bias in a districting plan. However, I also use two other metrics throughout this report to show that my conclusions about the historically large level of partisan bias in Michigan's plan are robust to the precise measure of gerrymandering that we use.

4.1 Measuring Gerrymandering using the Efficiency Gap

The Efficiency Gap (EG) focuses squarely on the number of each party's wasted votes in each election. It is defined as "the difference between the parties' respective wasted votes, divided by the total number of votes cast in the election" (Stephanopoulos and McGhee 2015, 831; see also McGhee 2014, 2017).[4] All of the losing party's votes are wasted if they

4. The Efficiency Gap calculations here focus on wasted votes in *legislative elections* since these results directly capture voters' preferences in these elections. However, we might also calculate the Efficiency Gap using district-level results from presidential elections or other statewide races. These have the "advantage of being (mostly) unaffected by district-level candidate characteristics" (Stephanopoulos and McGhee 2015, 868). This feature is particularly useful for simulating Efficiency Gaps from randomly generated districting plans since candidate characteristics are clearly influenced by the final districting plan. Presidential elections or other statewide races are less closely tied, however, to voters' preferences in legislative races given the district lines that actually exist. In practice, though, both legislative races and other statewide races produce similar Efficiency Gap results for modern elections where voters are well sorted by party and ideology. Indeed, the data indicate that the correlation between Efficiency Gap estimates based on congressional elections and presidential elections is approximately 0.8 for elections held after 2000 and 0.9 for elections held after the 2011 redistricting cycle.

lose the election. When a party wins an election, the wasted votes are those above the 50%+1 needed to win.

If we adopt the convention that positive values of the Efficiency Gap imply a Democratic advantage in the districting process and negative ones imply a Republican advantage, the Efficiency Gap can be written mathematically as:

$$EG = \frac{W_R}{n} - \frac{W_D}{n} \tag{1}$$

where W_R are wasted votes for Republicans, W_D are wasted votes for Democrats, and n is the total number of votes in each state.

Table 1 provides a simple example about how to calculate the Efficiency Gap with three districts where the same number of people vote in each district. In this example, Democrats win a majority of the statewide vote, but they only win 1/3 seats. In the first district, they win the district with 75/100 votes. This means that they only wasted the 24 votes that were unnecessary to win a majority of the vote in this district. But they lose the other two districts and thus waste all 40 of their votes in those districts. In all, they waste 104 votes. Republicans, on the other hand, waste all 25 of their votes in the first district. But they only waste the 9 votes unnecessary to win a majority in the two districts they win. In all, they only waste 43 votes. This implies a pro-Republican Efficiency Gap of $\frac{43}{300}$ - $\frac{104}{300}$= -20%.

Table 1: Illustrative Example of Efficiency Gap

District	Democratic Votes	Republican Votes
1	75	25
2	40	60
3	40	60
Total	155 (52%)	145 (48%)
Wasted	104	43

In order to account for unequal population or turnout across districts,[5] the Efficiency Gap formula in equation 1 can be rewritten as:

$$EG = S_D^{margin} - 2 * V_D^{margin} \tag{2}$$

where S_D^{margin} is the Democratic Party's seat margin (the seat share minus 0.5) and V_D^{margin} is is the Democratic Party's vote margin. V_D^{margin} is calculated by aggregating the raw

5. See the National Conference of State Legislatures' 2010 Redistricting Deviation Table which shows the extent to which populations of all the districts in a plan vary, or differ collectively from the ideal equipopulous districts. http://www.ncsl.org/research/redistricting/2010-ncsl-redistricting-deviation-table.aspx.

votes for Democratic candidates across all districts, dividing by the total raw vote cast across all districts, and subtracting 0.5 (McGhee 2017, 11-12). In the example above, this equation also provides an Efficiency Gap of -20% in favor of Republicans. But it could lead to a slightly different estimate of the Efficiency Gap if districts are malapportioned or there is unequal turnout across districts.[6]

The Efficiency Gap mathematically captures the packing and cracking that are at the heart of partisan gerrymanders. A key advantage of the Efficiency Gap over other measures of partisan bias is that it can be calculated directly from observed election returns even when the parties' statewide vote shares are not equal. In either case, the Efficiency Gap measures the extra seats one party wins over and above what would be expected if neither party were advantaged in the translation of votes to seats (i.e., if they had the same number of wasted votes).

In the analysis that follows, I examine the historical trajectory of the Efficiency Gap in Michigan and the nation as a whole. For all legislative elections that were contested between two major party candidates, I use the raw vote totals for the Efficiency Gap calculation. For legislative elections that are uncontested (i.e., those that lacked either a Democratic or Republican candidate), we do not directly observe the number of people that support each party's candidate. In these cases, it is necessary to estimate the two-party vote share because "determining the degree of packing and cracking requires knowing how many people in each district support each party" (Stephanopoulos and McGhee 2015, 865). Using publicly available data and statistical models, I estimate the two-party vote share in each district based on previous and future elections in that district as well as the results in similar districts elsewhere. This is similar to the approach used in a variety of other studies that estimate either the Efficiency Gap (Stephanopoulos and McGhee 2015; Brennan Center 2017; Jackman 2017; McGhee 2018) or some other gerrymandering metric (e.g., Warrington 2018). The details of this calculation for uncontested races are described in further detail in the Appendix.

Now that we know voters' two-party preferences in contested districts and we have estimates of their preferences in uncontested districts, we are finally in position to estimate the partisan advantage in the legislative districting process during each state-year. I estimate the Efficiency Gap in the congressional and state legislative elections of nearly all states for each election between 1972 to 2016.[7]

6. In general, the two formulations of the Efficiency Gap formula yield very similar results. Because Democrats tend to win lower-turnout districts, however, the turnout adjusted version of the Efficiency Gap in equation 2 tends to produce results that suggest about a 2% smaller disadvantage for Democrats than the version in Equation 1 (see McGhee 2018).

7. I start the analysis in 1972 since those are the first districting plans drawn after the Supreme Court cases stemming from *Baker v. Carr* ended malapportionment and established the principle of one-person,

4.2 Other Measures of Partisan Bias in Districting Plans

In addition to the Efficiency Gap, a number of other statistical approaches have been proposed to measure partisan bias in a redistricting plan (e.g., Gelman and King 1994a, 1994b). All of these approaches have important strengths and weaknesses (McGhee 2014, 2017). Overall, I believe that the Efficiency Gap is the best measure of partisan bias in the districting process. However, I also use two alternative measures of gerrymandering throughout this report to show that my conclusions about the extremity of Michigan's plan are robust to the precise measure of gerrymandering that we use.

1. **Mean-median**: Some scholars have proposed that partisan bias in a districting plan can be measured using the difference between a party's vote share in the median district and their average vote share across all districts. If the party wins more votes in the median district than in the average district, they have an advantage in the translation of votes to seats (Krasno et al., forthcoming; Best et al. 2017). The mean-median difference is very easy to apply (Wang 2016). It is possible, however, for packing and cracking to occur without any change in the mean-median difference. That is, a party could gain seats in the legislature without the mean-median gap changing (McGhee 2017).[8] It is also sensitive to the outcome in the median district (Warrington 2018). Finally, the mean-median difference lacks an obvious interpretation in terms of the number of seats that a party gains through gerrymandering.

   Table 2 illustrates the mean-median approach using the district-level election results in the 2012 Michigan congressional elections. It indicates that many Democratic voters were packed into just 5 districts where the Democratic candidates won by overwhelming margins. The remaining Democratic voters were cracked across the other 9 districts, several of which were decided by very close margins. This table shows the disproportionate percentage of the statewide vote that Democrats would have needed to win a majority of Michigan's congressional seats in 2012.[9] Across

one-vote. Also, I validate my measures of the Efficiency Gap to make sure that they align closely with Efficiency Gaps calculated using alternative modeling approaches for uncontested races. In the Appendix, I show that my estimates of the Efficiency Gap are extremely highly correlated with a variety of other measures of the Efficiency Gap developed using different assumptions for the imputation of uncontested districts.

8. As McGhee (2017), notes, "If the median equals the win/loss threshold–i.e., a vote share of 0.5–then when a seat changes hands, the median will also change and the median- mean difference will reflect that change. But if the median is anything other than 0.5, seats can change hands without any change in the median and so without any change in the median-mean difference."

9. Democrats would have needed to win the 3rd District to win a majority of seats, and Democrats would have needed to win an additional 4.5% of the vote there to win–even though Democrats already

all districts, Democrats won an average of 53% of the vote. But they only won 46.1% in the median district (e.g., the median between the 3rd and 11th districts). As a result, Democrats lost at least two districts that they would have won if there was no difference between the mean and median districts. This translates into a mean-median difference in Michigan's 2012 election of 6.9%.

District	Democratic Vote Share
10	30.2%
04	34.7%
02	35.9%
08	38.9%
06	43.8%
07	44.6%
03	45.6%
11	46.6%
01	49.7%
09	64.5%
05	67.4%
12	70.1%
14	84%
13	85.9%
Mean	53%
Median	46.1%

Table 2: Results in 2012 Michigan Congressional Elections

2. **Declination**: The declination metric starts from the assumption that a plan drawn with the intent to advantage one party will arrange the distribution of district vote shares in a way that treats the 50 percent threshold for victory differently than other vote values (Warrington 2018).[10] In the absence of partisan intent, if all the districts in a plan are lined up from the least Democratic to the most Democratic, the mid-point of the line formed by one party's seats should be about as far from 50 percent on average as the other party's (McGhee 2018). When this condition is not met, the distribution might look more like the one in Figure 1, which shows the actual 2012 congressional results in Michigan. The districts won by Republicans (in red) are much closer to 50 percent than the ones won by Democrats (in blue).[11]

won 53.0% of the vote in the average district. In other words, Democrats would have needed to win about 57.5% of the vote to win a majority of the seats in Michigan's congressional delegation.

10. This discussion is adapted from the excellent summary of declination in McGhee (2018).

11. District numbers are shown for each result.

This distribution appears to be designed to ensure that Republican seats do not cross the 50 percent line, in part by packing the Democratic voters into a handful of seats.

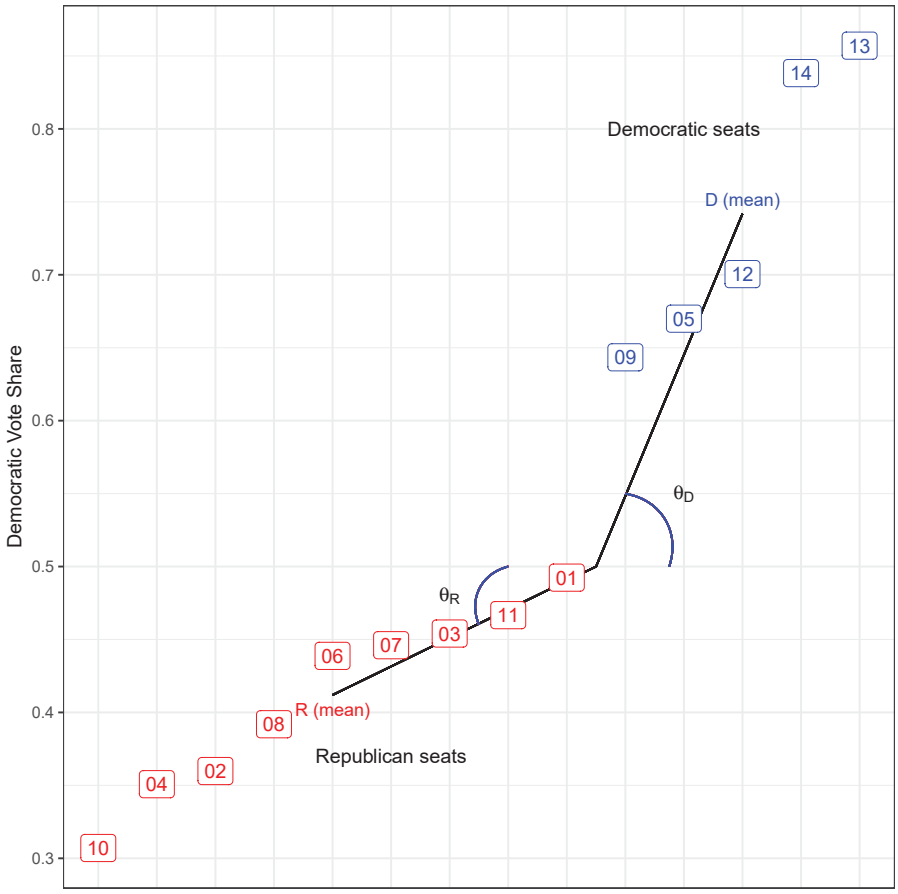

Figure 1: Declination in Michigan's 2012 Congressional Elections.

Declination suggests that when a plan is not deliberately drawn to favor one party, the angles of the lines (θ_D and θ_R) between the mean across all districts and the point on the 50% line between the mass of points representing each party will be roughly equal. When they deviate from each other, the smaller angle (θ_R in the case of Michigan) will generally identify the favored party. To capture this idea, declination takes the difference between those two angles (θ_D and θ_R) and divides by $\pi/2$ to convert the result from radians to fractions of 90 degrees.[12] This produces a number between -1 and 1. As calculated here, positive values favor Democrats and negative values favor Republicans.[13] Warrington (2018) suggests a further adjustment to

12. This equation is: $\delta = 2^* (\theta_R - \theta_D) / \pi$.

13. In order to validate my estimates of declination, I compare my estimates to the ones presented in Warrington (2018). I find that my declination estimates are nearly identical to the estimates originally

account for differences in the number of seats across legislative chambers. I use this adjusted declination estimate in the analysis that follows.[14]

A weakness of the declination approach vis-a-vis the Efficiency Gap is that declination lacks a clear interpretation in terms of the number of seats that a party gains through gerrymandering. It is also somewhat unstable when a party holds a very small number of seats in the legislature. However, some scholars have claimed that it represents a better measure of intent in the gerrymandering process than the Efficiency Gap (McGhee 2018). Moreover, it is arguably less sensitive to the outcome of a handful of close elections than the Mean-Median difference or the Efficiency Gap (Warrington 2018). In practice, though, the declination measure, $\hat{\delta}$, and the Efficiency Gap are highly correlated. The correlation between them is about .82 for congressional elections, .86 for state house elections, and .82 for state senate elections.

5 Gerrymandering in Congressional Districts

In this section, I will first provide an historical overview of the Efficiency Gap in congressional districts over the past 45 years. Next, I will show that Michigan's 2011 redistricting plan is historically extreme compared to both other states and its own plans in previous decades. Finally, I will show that partisan bias in congressional districts has real consequences for the representation that citizens receive in Congress.

5.1 Efficiency Gap in Congress

Figure 2 shows the distribution of Efficiency Gaps between 1972 and 2016 in states with more than 6 congressional seats.[15] It shows the relative proportion of states with different values of the Efficiency Gap. The Efficiency Gap in each election year is represented in the distribution.

developed by Warrington in the appendix to his article. In fact, the correlation between the declination values that I calculate and those in Warrington (2018) is .94 for the U.S. House and .96 for state house elections (note that Warrington does not estimate declination values for state senate elections). Small differences between the declination estimates likely stem from minor differences in how we impute vote shares in uncontested races.

14. This adjustment uses this equation: $\hat{\delta} = \delta * \ln(\text{seats}) / 2$

15. I focus on states with more than 6 congressional seats for two reasons. First, these states contribute less to the overall distribution of seats in Congress (Stephanopoulos and McGhee 2015, 868). Second, the Efficiency Gap in smaller states tends to be more volatile and thus less informative about partisan bias. For example, in a state with only three seats, a change in the winner of one seat could cause a huge shift in their Efficiency Gap.

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